REPORT

ON THE

PROPOSED SEWERAGE SYSTEM

FOR THE TOWN OF DERRY.

GEORGE H. ALLEN, CIVIL ENGINEER.

1893.

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SEWERAGE SYSTEM,

DERRY, N. H.

SURVEY AUGUST, 1892.

REPORT FEBRUARY, 1893.

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DERRY, N. H.:

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1893.

MANCHESTER, N. H., Feb. 16, 1893.

To V. H. Moody, A. J. Seavey, and L. M. Stearns, Selectmen of the Town of Derry, N. H.

GENTLEMEN: — In accordance with a letter received from your Chairman, Mr. Moody, dated June 24th, 1892, a survey, plans, profiles have been made of Derry Village and Derry Depot, for the purpose of designing a system of sewerage, and I now take pleasure in presenting you with this report in explanation of the plan and an estimate of the cost for construction.

The survey was commenced August 29th, and completed September 25th, 1893. A complete survey was made of all the streets of Derry Depot and Derry Village, and the highways joining the same; also of Beaver Brook, from Chase's Mill pond to Bogle's brook, about five hundred feet below the pumping station, and of Horne's brook from Beaver brook to the electric light station.

GENERAL REMARKS.

It will be unnecessary for me to enter into and take up your time with the complex formulas and theory of the flow and discharge of pipes, as there are plenty of works published at the present time that would explain the subject more thoroughly and completely than my time or space would permit.

The subject of sewerage for towns and villages is of comparatively recent origin. With the advancement of civilization and increase in wealth and business prosperity has come the introduction of water for the protection of property and for household use, causing a much larger quantity of sewage and waste to be disposed of; and the modern idea of paved and macadamized streets and improved highways has rendered it necessary to take

care of the surface water. The importance of effective drainage and sewerage has been shown in so many reports from professional men and government commissioners that its influence on health, strength and length of life is gradually beginning to be generally understood. The results of all inquiries abundantly demonstrate that drainage and sewerage are essential elements of health in populous districts. Independently of actual loss of life which so frequently attends their neglect, impaired mental or bodily vigor, arising from defective drainage and sewerage, reduces daily in thousands of cases the capabilities of individuals to such an extent that it may be considered equivalent to a loss of income by the deterioration or diminution it induces in the effective service which each can give to his occupation. Calculated as a matter of profit and loss, everything indicates that the expense required in establishing proper measures to avoid these evils would be far below the loss consequent upon the inefficient arrangement too frequently witnessed at present.

Various methods have been used to dispose of sewerage, but practice and experience have demonstrated that the method which will remove at once and completely from the vicinity of habitations the various sorts of refuse in the most expeditious manner is the one which must be the most conducive to health. The system which best performs this service is known as the water carriage system, or a system of service pipes leading from the house direct to some place of discharge and flushed or cleansed by automatic tanks of pure water in the house.

Two systems have been in use, known as the separate and combined systems. By the separate system the house drainage is kept in a series of pipes by itself, separate from the surface of street water. The combined system takes both the house and surface drainage into the same pipe. It has been urged that by the separate system very small impervious pipes can be used to conduct the house offal to a great distance from habitations, while the surface water can be taken in the shortest and most direct course into the adjacent streams without contaminating the water.

This last theory has been proved futile, for the rain-water, after taking up the impurities of the atmosphere, the dust and sediment of the house-tops and the droppings of the street, is fully as impure and dangerous as the house excrement and should be kept from the streams for the same reasons.

W. H. Canfield, M. D., professor of hygiene and public health at University College, London, in 1871, has said in regard to the the water carriage system, "We know that in the towns where it has been introduced in connection with other sanitary arrangements, it has been the means of practically annihilating cholera; and very little less effectual in in the extermination of typhoid fever. By the construction of deep drain sewers the mortality from phthisis has been greatly diminished."

For these reasons, and also on the ground of economy by saving one set of pipes, I shall in all cases recommend the combined system.

DESCRIPTION OF PLAN.

It is customary in New England to use the rivers and brooks as natural drains to carry away the refuse when possible. This is well enough when there are rapidly flowing rivers with quite a large body of water; but Derry has only a very small and very sluggish brook which may answer for an outlet for a time. But I am of the opinion that in time some of the modern mechanical means of disposal will have to be adopted, as in fact may be the case throughout the country in order to preserve our water courses. The point of discharge selected for your system is in the bend of Beaver brook, about six hundred feet below the pumping station, and four hundred feet below the wells. I do not dare to come any nearer the wells. It is not known at present just what the limit of sewage penetration is. Wells have been known to be contaminated by sewage discharged three hundred feet away. But this sewer discharging into the running water below the wells and below the bend, will, I think, prevent its working back up stream.

THE MAIN.

The main sewer is to be a 15-inch Akron pipe, commencing at the brook, following the banks to and across Washington street about 20 feet from the bridge, thence continuing on the bank of the brook to the middle of South Avenue ; thence through South Avenue under Horne's brook to Factory Street, and in the rear of the shoe shop boarding house and Abbott's house, under the railroad and through the field to the middle of Railroad Avenue.

BRANCHES.

Broadway between Pine and Railroad Avenue and all the section north of it will be drained by a 12-inch pipe connecting with the main at the lowest point in Railroad Avenue, as will also the rest of Railroad Avenue and a part of North Avenue. South Avenue from another sub-main draining the Birch and Pine Street flats, also the Highlands through Highland Avenue. Brook Street must be drained backwards, as it were, joining the main at South Avenue. I found it would be cheaper to put in the two sewers parallel than to put the main through Brook Street, owing to the great depth of cutting that would be required at the south end of Brook Street. St. Martin's Court and a part of Broadway will join the main through Abbott's Court. The 15-inch main will be continued on the bank of Horne's brook from South Avenue to Broadway, taking all of Broadway drainage from Factory Street to Londonderry line ; also a part of Maple Avenue, Washington and High Streets. It will also be necessary to construct a 12-inch main sewer on the bank of the brook from South Avenue to the angle in Maple Avenue at the electric light station, which will form an outlet for High Street, Maple Avenue, and all that section between Maple Avenue and Franklin Street when called for. In order to drain the Clark Street region it will be advisable at some future time to get a street running direct to the brook in the lowest place, as Washington Street is too high to drain the low ground. Washington Street must have an independent sewer by itself. In order to drain Mt. Washington and Broadway between

there and Pine street it will be necessary to construct a main from the manhole at the Washington Street bridge crossing over Horne's brook and passing around the side hill to the manhole shown, 600 feet from Mt. Washington Avenue. This line has not been shown on the plan because another survey line is necessary, and as that is so far in the future I did not deem it advisable to make it at this time, but the profile of the brook line surveyed, which is shown by the dotted red line on the plan, will enable an engineer at any future time when called for to very easily locate a line that will give the proper grade.

PLANS AND PROFILES.

With the above description the maps will be readily understood. It shows the size and direction of each sewer, also the location of the manholes and lampholes, except on such streets as have not been profiled. The profiles show the grades of all sewers on the streets profiled, the depth of cutting required and the location of manholes and lampholes.

PREPARING THE TRENCH.

The trench should be dug with the sides as nearly vertical as possible, and be about one foot wider than the outside diameter of the pipe at a point six inches above the bottom and the remainder rounded out to fit the outside of the pipe, and smooth and uniform. At the joints the places for the rings or sockets should be cut out with a trowel as the pipe is laid so that the body of the pipes will have solid bearing on the solid earth its entire length.

BRACING.

If the soil is too loose or porous to stand by itself the sides should be carefully braced to prevent caving. This may be done with 2-inch plank, with 2x4 studding and 2x4 cross bracing. This is the old method, but the large cross braces use up a great amount of

space and much valuable time is taken up in getting them in place and spiking them, and afterwards removing them. It is cheaper in the long run to use iron braces made for the purpose, being hollow iron cylinders with double screw heads, one on each side like a common jack screw. For trenches 8 or 10 feet deep, each section 16 feet long will require the following material:

LUMBER.

10	pieces	2x10,	16	feet	long.	550 feet B. M,
36	"	1x10,	7	"	"	
4	"	2x8,	7	"	"	
4	"	3x6,	16	"	"	
4	"	3x6,	1	"	"	

IRON SCREWS.

2	screws	36	inches	long	closed.
2	"	30	"	"	"
2	"	24	"	"	"

These will do for a trench 4 feet at top and 40 inches at bottom, large enough for an 18-inch pipe.

For a trench 13 or 14 feet deep, each 16 feet in length will require:

10	pieces	2x10,	16	feet	long,	829 feet.
72	"	1x10,	7	"	"	
8	"	2x8,	7	"	"	
8	"	3x6,	16	"	"	
6	"	3x6,	1	"	"	

IRON SCREWS.

2	screws	36	inches	long	closed.
1	"	30	"	"	"
1	"	24	"	"	"
2	"	20	"	"	"
2	"	14	"	"	"

This for a trench 4 feet at top, 30 inches at bottom. This will do for a 12-inch pipe.

SPRINGS.

Should living springs be encountered in the trench they should be carried away in small pipes to some convenient outlet, anywhere to keep it from running down the pipe trench.

DEPTH.

On streets where the sewer grade is not established, the sewer grade should not be less than eight feet below the street grade, in order to give sufficient grade for the soil pipe and sink drainage. In a few cases I have been obliged to be content with a less depth, in order to get sufficient grade for the main; also a few cases where the street will have to be filled.

LINE AND GRADE.

The line and grade may be marked on the ground by batters on the surface extending across the trench, the top of the batter board to be some even foot above the grade given on the profile, say eight, ten or twelve feet, according to the depth of the cutting, the line marked by nails in the top of the butters. The grade shown on the profile is the water line or inside bottom of the pipe. The batters should not be more than 25 feet apart, and on some of the very flat grades and in deep trenches it would be well to set grade pegs in the bottom of the trench. These grades and lines must be set very carefully.

PIPE LAYING.

All sewers should be laid in a straight line and true grade from manhole to lamphole. The old style of pipe laying, by twisting around and lifting over boulders has been proved to be a very expensive economy, the twists and bends forming obstructions to the free passage of the solids, and causing the sewer to clog and fill, and in a few years become worthless and have to be relaid. It also renders worthless the manholes and lampholes, for unless the pipe is perfectly straight, it being of so small a diameter, it

will be impossible to see from one to the other in order to locate any obstruction. The mason should be provided with rubber mittens. He can then carefully pack the cement in and around the joints; the inside of the joint should be carefully smoothed by hand, and all cement dropping cleaned out of each length before the next one is laid. All cobbles and sand should also be removed, so that there will be nothing in the sewer to form a lodging place for the solid sewage passing through. A very slight obstruction will stop the first particle that reaches it, and on that the sediment will gradually accumulate until in time you will find the sewer blocked, and the town put to great expense to cleanse it, to say nothing of a probable bill of damages for a setback into the houses. You cannot be too careful in preserving the smoothness of the joints and cleanliness of the pipe. All water in the trench should be dammed back until the joints have had a few hours to set before allowing it to pass off through the sewer.

On leaving the trench at night the end of the pipe laid should be solidly packed with old sacking and covered with a wooden cover a little larger than the outside diameter of the sewer. This cover to be braced solidly against the end of the sewer, so that in case of a sudden shower in the night or any other accident the sewer will not be filled with mud and sand. Should such an accident happen, it should be cleaned out before proceeding further, by digging out with a hoe all that can be, then going to the various manholes below and with a hose attached to the nearest hydrant thoroughly loosen and soften the mud from the lower side, so that it will flow off freely.

BACK FILLING.

The back filling should be placed in the trench in a careful manner, not thrown in, and no stones allowed. It should be in layers of not more than six inches in depth and thoroughly tamped under and around the pipe until every square inch of surface has a solid bearing. This is to be continued until the sewer

is covered at least one foot in depth. Afterward the filling may be tamped with heavy mauls or puddled.

MANHOLES AND LAMPHOLES.

There should be a manhole at every sewer junction, and a manhole and lamphole alternating at every angle and change of grade, provided they are not more than three or four hundred feet apart, for ventilation, facility in examination and ease in cleaning in case of obstructions.

The manholes are made of brick, $2\frac{1}{2}$x4 feet on the bottom, gradually drawing as it approaches the top into a circle 26 inches in diameter at a point one foot below the surface of the street. The walls should be 8 inches thick, of hard burned brick, and carefully constructed inside and out. The bottom should be 8 inches thick composed of two layers of brick so laid as to break joints, and covered with a thick coating of cement mortar. This coating should be flush with the water line of the sewer. After the first coat has thoroughly hardened and set, it should be washed with a thin wash of pure cement, in order that any cracks or air spaces caused by setting may be thoroughly filled. If so desired, 8-inch iron pins may be inserted in the joints two and one-half feet apart, projecting four inches, this forming a permanent ladder for access, or a common ladder may be used. In very wet places a concrete foundation 6x$7\frac{1}{2}$ feet, 8 inches thick, may be needed to prevent settling. The manhole cover and circle should be of iron, of about 475 lbs. weight, the cover to have about 20 perforations, conical shaped, one inch on bottom, 3-4 inch on top, for the purpose of ventilation. These covers should be level with the surface of the street, and great care taken that they be kept clear on top. Many highway surveyors think that when they repair the street the manhole cover must be buried up a foot. This must not be allowed; the openings must be kept clear so the gas can escape from the sewer.

The lampholes are made of 6-inch Akron pipe, rising vertically from the top of the sewer from a T branch, covered with an iron cover set in a ring the same as the manhole. The cover should be perforated for ventilation. They should be carried up with the filling, and great care taken that they are perfectly vertical, In soft, wet places it may be necessary to stand them on a concrete bottom, two feet square.

Y BRANCHES.

While laying the pipes Y branches should be put in wherever any connection is to be made, either from house drains or catch basins, and also wherever there is liable to be any connection made in the future. The Y should be so laid in the trench that the projection shall be from the upper quarter; in other words one-half the diameter of the main sewer should be below the inlet.

Wherever branches are put in that are not to be used immediately the ends should be plugged with earthen p'ugs prepared for the purpose, and cemented in perfectly tight; then when they are wanted all that is necessary will be to break the plugs. These plugs of every size can be procured with the pipe.

Wherever a branch is put in it should be accurately located by measure from the last manhole, and a record made, either on the plan or in a book, showing its location, size and direction, so that it can be easily found at any time.

All sewer connections must be made with a branch and under the direction of some competent town official appointed for that purpose, and not left to any and every person who thinks he can lay sewer pipe. More damage can be done to sewers in one season by incompetent workmen making connections than would pay for half a dozen competent inspectors. The habit of trying to save expense by omitting the Y's that may be needed in the future, and allowing connections to be made by cutting into the main sewer, is another expensive economy, as the chances are more than even that the sewer will be cracked either side of the connection, or the connecting pipe left projecting into the sewer

so as to cause an obstruction, either of which will make it necessary to relay the sewer in a year or two at great expense.

CATCH BASINS.

The catch basins should be circular brick walls, $3\frac{1}{2}$ feet in diameter and 6 feet deep. The walls and bottom to be 8 inches thick, coated inside and out with cement, the inside coat up to the top of the trap should be Portland cement to insure its being perfectly water tight.

The traps should be of cast iron, shaped somewhat like a flour scoop, hung upon a hinge, so that it can be raised and the sides of the catch basin thoroughly cleaned.

The catch basin should be built under the gutter and outside edge of the sidewalk. Across the top of the well should be placed a granite curb, 7 feet in length, the top to be on the grade of the sidewalk. In the side of the curb should be cut a depression 4 inches deep, 15 inches long and 8 inches high, to form an inlet into the catch basin. One inch below the grade of the gutter should be an iron grating, the straight side resting against the curb stone, the circular sides resting upon the circular sides of the catch basin, which should be made to fit the grate. The surface water from the gutter will enter the catch basin through the grate, the aperture in the stone receiving the water if the grate becomes clogged with leaves and mud.

The catch basins should be thoroughly cleaned at least once a month, and in times of drought great care should be taken to keep the traps thoroughly sealed by filling with water from the hydrants as fast as it evaporates.

The catch basins could not be shown on the plan at present as their location will be governed by local circumstances at the time of construction, and can be put upon the plan when built.

SURFACE STREAMS.

All brooks or surface water of any kind, that it may be necessary to take into the sewer must first be received into a catch

basin, that all sediment, leaves, sticks, etc., may be kept out of the sewer.

FLUSHING,

The sewer should be occasionally flushed or cleaned. This may be done either by a hose from the hydrants put down into the sewer through a manhole, or by the method adopted in New Haven, of having a large vertical tank on wheels, a canvas hose of equal diameter with the sewer, and a wooden slug, 12 inches long, of one inch less diameter than the sewer; to the end of the slug is attached a cord a little longer than the distance between manholes. The slug is put into the end of the sewer, the cord laying loose on the sufrace of the ground, the hose then inserted into the sewer and the water let loose from the tank. When the ball appears at the next manhole you may be sure the sewer is free from obstructions.

A better, because a surer method of flushing is by means of automatic flushing tanks, filled from the water service, and discharging once in 12 or 24 hours, just as you see fit to gauge them. There are a great variety of tanks made. The Field tank is, I think, as good as any; the cost is about seventy-five dollars. It may be found necessary to put one in at the foot of Washington street on account of the very flat grade of the main. A short trial without doubt will settle the question.

VENTILATION.

All sewers should be ventilated by the perforated manhole and lamphole covers and at the dead end of all sewers the gas should have a free chance to escape, either through a manhole or lamphole. I have shown lampholes only at the dead end of some of the smaller sewers, but they should have perforated covers. The large sewers should end in a manhole.

ESTIMATES.

Estimates have been made only of such streets as were profiled. The price of pipe and cement being somewhat variable, I have made the estimate from about an average price. The finding of boulders and ledges in unexpected places may also change them a little. Catch basins and branches are not included.

Main sewer from brook to Railroad Avenue.

The profile from which this estimate was made was compiled from several others, and there were no levels from Washington Street to South Avenue on the bank of the brook. It will be well to make a new profile of this line before commencing the work. This one will serve to fix the grades.

COST.

3770 feet 15-inch Akron pipe at $0.62,	$2,337 40
120 feet 14-inch iron pipe at $30.00 per ton,	180 00
75 bbls. cement at $1.50,	112 50
Excavation,	1,294 30
Tunnelling under railroad,	300 00
9 manholes,	579 50
6 lampholes,	60 00
Mason and tender 75 days at $5.00,	375 00
4 M lumber for bracing,	80 00
Incidentals and engineering 20 per cent.,	1,063 74
Total,	$6,382 44

I should recommend tunnelling and the use of iron pipe under the railroad.

RAILROAD AVENUE.

624 feet 12-inch Akron pipe at $0.44,	$274 56
161 feet 10-inch " " at 0.33,	53 13
8 bbls. cement at $1.50,	12 00
Excavation,	529 80

2 manholes,	147 60
3 lampholes,	30 00
Mason and tender 16 days at $5.00,	80 00
1 M lumber,	20 00
Incidentals and engineering,	229 42
Total,	$1,376 51

BROADWAY.

Mt. Washington to Pine Street.

1037 feet 12-inch Akron pipe at $0.44,	$456 28
10 bbls. cement at $1.50,	15 00
Excavation,	511 53
4 manholes,	263 00
1 lamphole,	10 00
Mason and tender 21 days at $5.00,	105 00
1 M lumber,	20 00
Engineering and incidentals 20 per cent.,	276 16
Total,	$1,656 97

PINE STREET TO RAILROAD AVENUE.

1132 feet of 22-inch Akron pipe at $0.44,	$498 08
12 bbls. cement at $1.50,	18 00
Earth excavation,	1,495 00
Rock excavation, 60 yards,	240 00
4 manholes,	317 50
1 lamphole,	10 00
Mason and tender 23 days at $5.00,	115 00
3 M lumber,	60 00
Engineering and incidentals,	550 72
Total,	$3,304 30

BROADWAY COURT.

Railroad Avenue to Factory Street.

488 feet 10-inch Akron pipe at $0.33,	$161 04
5 bbls. cement at $1.50,	7 50
Excavating,	336 72
1 manhole,	66 70
2 lampholes,	20 00
Mason and tender 10 days at $5.00,	50 00
1 M lumber,	20 00
Engineering and incidentals,	132 39
Total,	$794 35

FACTORY STREET TO HORNE'S BROOK.

868 feet 12-inch Akron pipe at $0.44,	$327 92
8 bbls. cement at $1.50,	12 00
Excavation,	384 00
3 manholes,	189 90
3 lampholes,	30 00
Mason and tender 15 days at $5.00,	75 00
2 M lumber,	40 00
Engineering and incidentals,	223 76
Getting under brook, coffer dam, etc.,	50 00
Total,	$1,342 58

BROADWAY COURT.

Horne's brook to Londonderry line.

2081 feet 12-inch Akron pipe at $0.44,	$915 64
21 bbls. cement at $1.50,	31 60
Excavation,	1,268 74
5 manholes,	320 76
5 lampholes,	50 00
Mason and tender 42 days at $5.00,	210 00
2 M lumber,	40 00
Engineering and incidentals,	567 33
Total,	$3,403 97

TOTAL BROADWAY ESTIMATES.

Mt. Washington to Pine Sireet,	$1,656 97
Pine Street to Railroad Avenue,	3,304 30
Railroad Avenue to Factory Street,	794 35
Factory Street to Horne's brook,	1,342 58
Horne's brook to Londonderry line,	3,408 97
Total cost,	$10 502 17

FATORY STREET.

I have divided this estimate into two parts, one of which is already included in the main estimate.

PORTION INCLUDED IN THE MAIN.

580 feet 15-inch Akron pipe at $0.62,	359 60	
11 bbls. cement at $1.50,	16 50	
Excavation,	304 50	
1 manhole,	63 30	
1 Lamphole,	10 00	
Mason and helper 11 days at $5.00,	55 00	
2 M lumber,	40 00	
Incidentals and engineering,	169 78	
		$1,018 68

PORTION UP THE HILL NOT INCLUDED IN THE MAIN SEWER ESTIMATE.

400 feet 10-inch Akron pipe at $0.33,	$132 00	
4 bbls. cement at $1.50,	6 00	
Excavation,	276 00	
2 manholes,	133 40	
1 lamphole,	10 00	
Mason and tender 8 days,	40 00	
Engineering and incidentals,	119 48	
		$716 88
Total cost of Factory street,		$1,735 56

WAHSINGTON STREET.

1755 feet 12-inch Akron pipe at $0.44,	$772 20
314 feet 10-inch " " at 0.33	103 62
21 bbls. cement at $1.50,	31 50
Excavation,	1,864 93
6 manholes,	437 10
5 lampholes,	50 00
Mason and tender 50 days at $5.00,	250 00
4 M lumber,	80 00
Engineering and incidentals,	717 87
Total,	$4,307 22

One-fourth of this expense could be taken from sewer account and used for grading street much to the advantage of both.

BROOK STREET.

1095 feet 12-inch Akron pipe at $0.44,	$481 80
11 bbls. cement at $1.50,	16 50
Excavation,	1,511 10
3 manholes,	199 70
2 lampholes,	20 00
Mason and tender 22 days,	110 00
2 M lumber,	40 00
Engineering and incidentals,	475 82
Total,	$2,854 92

SOUTH AVENUE.

830 feet 15-inch Akron pipe at $0.62,	$514 60
1118 feet 12-inch " " at 0.44,	491 92
577 feet 10-inch " " at 0.33,	189 41
33 bbls. cement at $1.50,	49 50
Excavation,	2,667 55
7 manholes,	511 70
5 lampholes,	50 00
Mason and helper 51 days at $5.00,	255 00
5 M lumber,	100 00
Engineering and incidentals,	960 94
	$5,795 62

230 feet of above included in Main estimate.

BIRCH STREET.

490 feet 12-inch Akron pipe at $0.44,	$215 60
560 feet 10-inch " " at 0.33,	181 50
10 bbls. cement at $1.50,	15 00
Excavation,	926 40
4 manholes,	278 30
1 lamphole,	10 00
Mason and tender 21 days at $5.00,	105 00
2 M lumber,	40 00
Engineering and incidentals,	354 36
	$2,126 16

PINE STREET.

650 feet 10-inch Akron pipe at $0.33,	$214 50
6 bbls. cement at $1.50,	9 00
2 manholes,	126 60
1 lamphole,	10 00
Excavation,	448 50
Mason and tender 13 days at $5.00,	65 00
1 M lumber,	20 00
Engineering and incidentals,	178 72
Total,	$1,072 32

FRANKLIN STREET.

1255 feet of 12-inch Akron pipe at $0.44,	$552 20
12 bbls. cement at $1.50,	18 00
Excavation,	2,655 00
4 manholes,	281 70
3 lampholes,	60 00
Mason and tender 30 days at $5.00,	150 00
Engineering and incidentals,	743 38
Total,	$4,460 28

MAPLE AVENUE.

237 feet 10-inch Akron pipe at $0.33,	$78 21
1185 feet 12-inch " " at 0.44,	521 40

14 bbls. cement at $1.50,	21 00
Excavation, earth,	1,472 00
" rock,	240 00
4 manholes,	268 80
5 lampholes,	50 00
Mason and tender 30 days at $5.00,	150 00
Engineering and incidentals,	560 28
Total,	$3,361 69

HIGH STREET.

1650 feet 12-inch Akron pipe at $0.44,	$726 00
450 feet 10-inch " " at 0.33,	148 50
21 bbls. cement at $1.50,	31 50
Rock excavation, 678.6 yards, at $4.00,	2,714 40
Earth "	917 00
6 manholes,	419 40
5 lampholes,	50 00
Mason and tender 50 days at $5.00,	250 00
1 M lumber,	20 00
Engineering and incidentals,	1,055 36
Total,	$6,332 16

CRYSTAL AVENUE.

1955 feet 12-inch Akron pipe at $0.44,	$860 20
20 bbls. cement at $1.50,	30 00
5 manholes,	342 90
5 lampholes,	50 00
Rock excavation, 618 yards, at $4.00,	2,472 00
Earth "	867 10
Mason and tender 40 days at $5.00,	200 00
1 M lumber,	20 00
Engineering and incidentals,	968 44
Total,	$5,810 64

PEARL STREET.

355 feet 10-inch Akron pipe at $033,	$110 55
3 bbls. cement at $1.50,	4 50

1 manhole,	63 30
1 lamphole,	10 00
Excavation,	157 45
Mason and tender 7 days,	35 00
1 M lumber,	20 00
Incidentals and engineering,	80 10
Total,	$480 96

SUMMARY OF ESTIMATES.

Main line,	$6,382 44
Railroad Avenue,	1,376 51
Broadway,	10,502 17
Factory Street,	716 88
Washington Street,	4,307 22
Brook Street,	2,854 92
South Avenue,	5,795 62
Birch Street,	2,126 16
Pine Street,	1,072 32
Franklin Street,	4,460 28
Maple Avenue,	3,361 69
High Street,	6,332 16
Crystal Avenue,	5,810 64
Pearl Street,	480 96
Total,	$55,579 97

I should recommend the use of Akron pipe and the ring pipe in preference to the socket pipe, as better joints can be made, and the lengths of pieces for the smaller sizes are one foot longer, making the cost of laying less.

It will be seen that I have not shown many manholes and no lampholes on those streets that have not been profiled, as these can only be located where the changes of grade come, unless there are very long changes. When in the future the profiles are made, and their location determined, they should be put upon the plan.

All catch basins and branch connections should be put upon the plan as soon as constructed. The map should be kept up to date by putting upon it all new streets as soon as laid out, and any sewers built in them made to comform with the present system. Whenever a sewer is built it should be marked on the plan and profile, where begun and where ended, and the year of construction.

STREET GRADING.

The expense of your sewerage would be much lessened if your streets had been properly graded. This is a matter that should receive your attention.

DERRY VILLAGE.

I have found it impossible to drain this village by a sewer in the valley of the brook. The brook has a fall of only 7½ feet in a distance of 11,800 feet, giving a fall of only ¾ of an inch in 100 feet, not sufficient to render the sewer self-cleansing.

On the profile of the brook line I have shown the grade necessary to make a perfectly safe and self-cleansing sewer, and the figures in red show just how much the new line must be raised above the preliminary survey line, which will enable any engineer to locate a new line directly from this one without further investigation.

Such a sewer must be 24 feet above main street at the brook, and would drain all the land as high as the postoffice, but the lower portion cannot be drained automatically. It will therefore be necessary to resort to some of the various mechanical methods of disposal, such as pumping, pneumatic tubes, filtration, chemical precipitation or irrigation. Any and all of these systems are very expensive. As I was limited in time, and knowing that your citizens were not yet ready to bear the expense of sucha system, I have not taken the time to give this subject a thorough investigation. Thereby saving you the expense at the present time.

The system that will prove most satisfactory to the town in the end, it being the only one that will carry the sewage entirely away from habitations before it has time to decompose and cause

trouble, is to put a small pump down in the meadow and pump the sewage up into the high main spoken of above, then allowing it to flow away by gravity with the rest of the sewage. Such an arrangement could probably be constructed for about ten thousand (10,000) dollars.

Another method will be to construct gravel filter beds on the flats which will separate the solids and the liquids. The solids would then have to be scraped together and carted away. The liquids would have to be treated to some process of chemical precipitation, and even then all the impurities would not be removed.

The utilization of sewage as a manure for agricultural purposes has not yet been a successful or paying investment.

I have not shown any system on the plan for the reason that it will require very much more investigation, and I do not think the size of the village will warrant the expenditure at the present time.

The work that has been already done has not been wasted, for no investigation could be made without it, and it can be used in future just as well as at present.

CONCLUSION.

The profiles have been made on a large sheet to prevent their getting separated and lost. When they are required for use in construction they can be cut out and put in the roll, as the main profile is now. Owing to their great length the profile of the brook and of Broadway are made in two sections. It will be seen that a short portion is duplicated on each.

My thanks are due to the board of selectmen for their kindness and courtesy, and to Mr. Joseph R. Clark and Mr. Wheeler in assisting me in making the survey. The services of Mr. Clark were of great value owing to his knowledge of the country.

Respectfully submitted.

GEORGE H. ALLEN.

Civil Engineer.